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ABSTRACT

This booklet was designed to increase awareness about the metric system. Why the metric system is being used increasingly is described. Pictures illustrate simple comparisons of the most commonly used units of the metric and customary systems. Calculations using both systems are compared through presentation of three problems. Next, everyday units of measurement are listed. Finally, what metric use will mean in the marketplace, in the home, and at work are discussed. (MNS)

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All About Metric

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All About Metric

You use weights and measures every day of your life. Without them, shopping, trade, recreation, and education would be in a state of hopeless confusion.

You learned the language of measurement so early that you have probably forgotten the day you first understood the meaning of "inch, foot, yard, and mile"; of "ounce, pound, and ton"; of "pint, quart, and gallon"; and that "100 °F" is uncomfortably hot, while "30 °F" is uncomfortably cold. These are familiar units of the "customary" system of measurement.

Not as familiar to most Americans are the terms used in the metric system—terms such as "meters, liters, and grams." Increasingly, however, Americans are buying and using products labeled in metric language or manufactured to metric standards.

Recognizing the increasing use of metrics in the United States, Congress passed the Metric Conversion Act, which was signed into law by President Ford on December 23, 1975. This act, which created the United States Metric Board, established for the first time a national policy to coordinate voluntary metric conversion activities.

The names of the units in the metric system may sound strange to the American ear at first, but fortunately there are only a few words that have to be learned for everyday use. These are: the *kilometer*, *meter*, *centimeter*, and *millimeter* for expressing length and distance; the *liter* and *milliliter* for capacity and volume; the *kilogram*, *gram* and *metric ton* for mass (weight); the degree *Celsius* for temperature; the *kilopascal* for pressure; and the *hectare* for area.

Several metric units of measure have been in common use for decades.

The metric system is already being used in this country to a greater extent than most people realize. The cars we drive, the beverages we drink, the movies we watch and many other products we use in our everyday lives make use of the metric system. In international athletic competition, such as swimming and track and field events, length measurements are given in meters rather than in yards and feet. Our astronauts, from the surface of the moon, excitedly told a worldwide audience how far in meters they had landed from a lunar landmark. You see mass (weight) expressed in grams on more and more packaged items at the grocery store.

Why is the Metric System Being Increasingly Used?

The metric system is increasingly in use throughout the world. It is a scientific system based on decimals.

In the metric system each quantity, such as length (meter) or mass (gram), has its own unit of measurement, and no unit is used to express more than one quantity. In the customary system, however, pound can mean either force, as in pounds required to break a rope, or mass (weight), as in a pound of sugar; and ounce can mean either volume, as in the number of ounces in a quart, or mass (weight), as in the number of ounces in a pound.

The metric system is easy to learn to use in solving problems that involve computation. This is because multiples of metric units are related to each other by the factor 10. You have probably noticed that the names of metric units sometimes include prefixes such as *milli*, *centi*, and *kilo* as in *milliliter*, *centimeter*, and *kilogram*. These prefixes indicate multiples or divisions of the units.

Consider the measurement of length—in the metric system any measurement of length is expressed in meters or multiples of the meter. A centimeter is one-hundredth of a meter; a millimeter is one-thousandth of a meter; and a kilometer is one thousand meters. In the customary system, an inch is one-twelfth of a foot; a foot is one-third of a yard; and a mile is 5,280 feet.

The most commonly used prefixes, and the multiplication factors they indicate are given on the following pages.

Mass (Weight)
1 kilogram = 1 000 grams
1 hectogram* = 100 grams
1 dekagram* = 10 grams
1 gram = 1 gram
1 decigram* = 0.1 gram
1 centigram* = 0.01 gram
1 milligram = 0.001 gram

Length
1 kilometer = 1 000 meters
1 hectometer* = 100 meters
1 dekameter* = 10 meters
1 meter = 1 meter
1 decimeter* = 0.1 meter
1 centimeter = 0.01 meter
1 millimeter = 0.001 meter

*units not commonly used

Volume

1 kiloliter*	= 1 000 liters
1 hectoliter*	= 100 liters
1 dekaliter*	= 10 liters
1 liter	= 1 liter
1 deciliter*	= 0.1 liter
1 centiliter*	= 0.01 liter
1 milliliter	= 0.001 liter

*units not commonly used

Temperature

Prefixes are not commonly used with temperature measurements as they are with those for mass (weight), length, and volume. Temperatures in degrees *Celsius*, as in the familiar *Fahrenheit* system, can only be learned through experience.

Doubling the degrees Celsius temperature and adding 30 will give you a good approximation of the temperature in degrees Fahrenheit. In a like fashion, subtracting 30 from the degrees Fahrenheit and then dividing by two will give you a good approximation of the temperature in degrees Celsius.

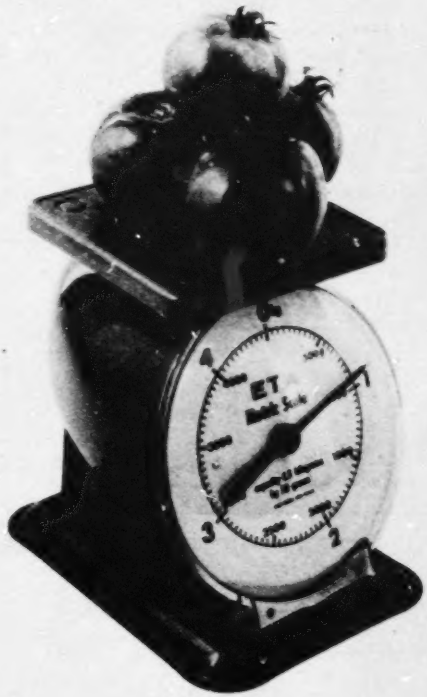
The following may help to orient you with regard to temperatures you normally encounter.

0°C	Freezing point of water (32 °F)
10°C	A warm winter day (50 °F)
20°C	A mild spring day (68 °F)
30°C	Quite warm—almost hot (86 °F)
37°C	Normal body temperature (98.6 °F)
40°C	Heat wave conditions (104 °F)
100°C	Boiling point of water (212 °F)

Metric/Customary Comparisons

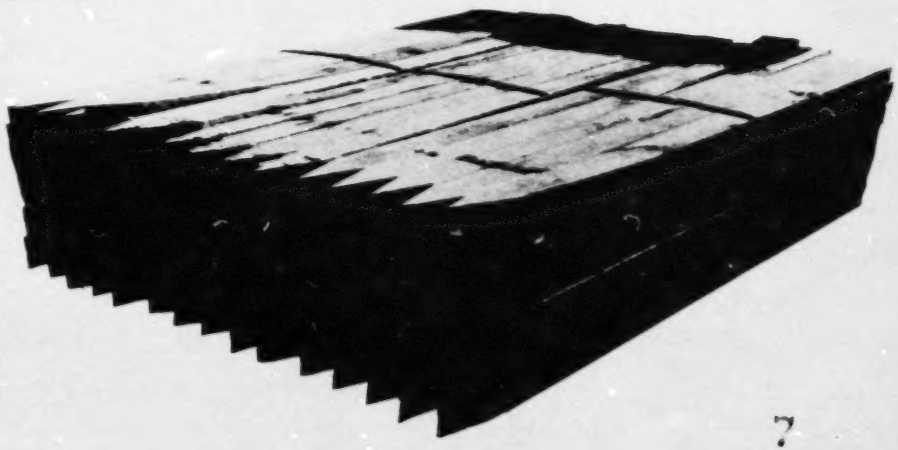
The following examples illustrate simple comparisons of the most commonly used units of the metric and customary systems.

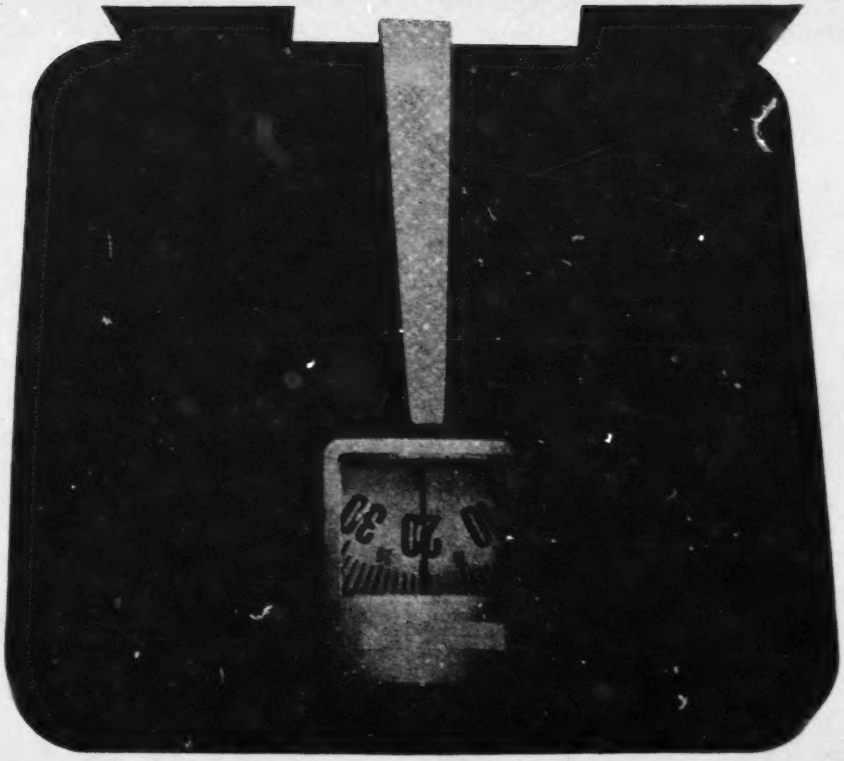
Small Quantities
For weighing quantities of things such as tomatoes, grams are used instead of ounces. For example, 900 grams is about 32 ounces.



Small Linear Dimensions
For expressing small linear dimensions such as wrench sizes, the metric system uses millimeters instead of inches. For example, a 19 millimeter wrench would be used instead of a ¾ inch wrench.

Larger Linear Dimensions
In expressing larger sizes, the meter and centimeter replace the yard and inch.

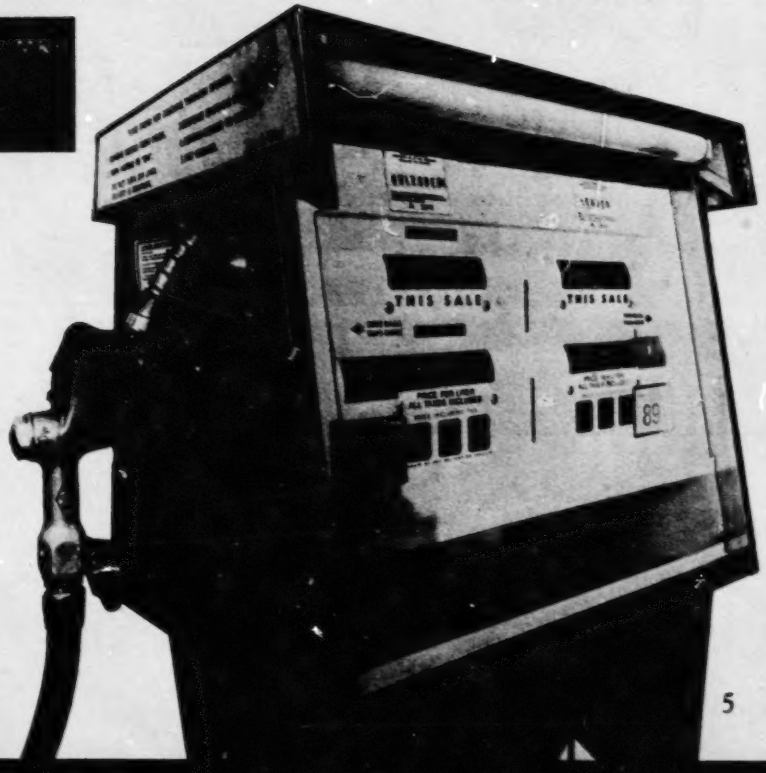




Larger Quantities
For weighing larger items such as furniture, animals or humans, kilograms rather than pounds are used. A bathroom scale will read 19 kilograms instead of 41 pounds.

Volume
When you order a tankfull of gasoline, you may note that it will take 60 liters rather than 16 gallons.

Speed/Distance
Our automobile speedometers now show kilometers per hour as well as miles per hour. If the kilometer replaces the mile in common use, road signs will represent distances and speed limits in kilometers and kilometers per hour.



Mass (weight)

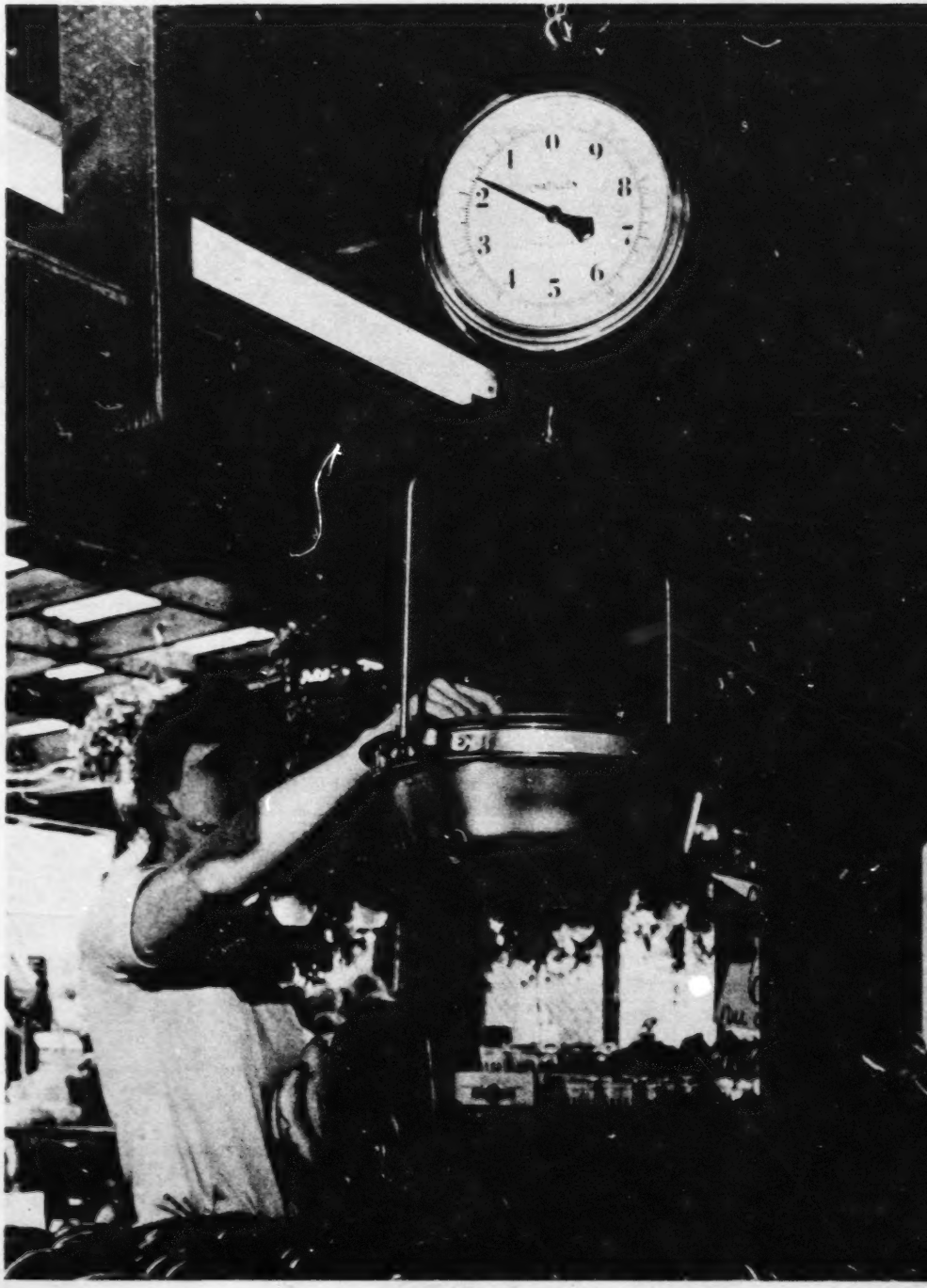
1 kilogram (1 000 grams) is a little more than 2 pounds

500 grams is a little more than 1 pound

250 grams is a little more than 1/2 pound

100 grams is a little less than 1/4 pound

1 gram is about the weight of a paper clip

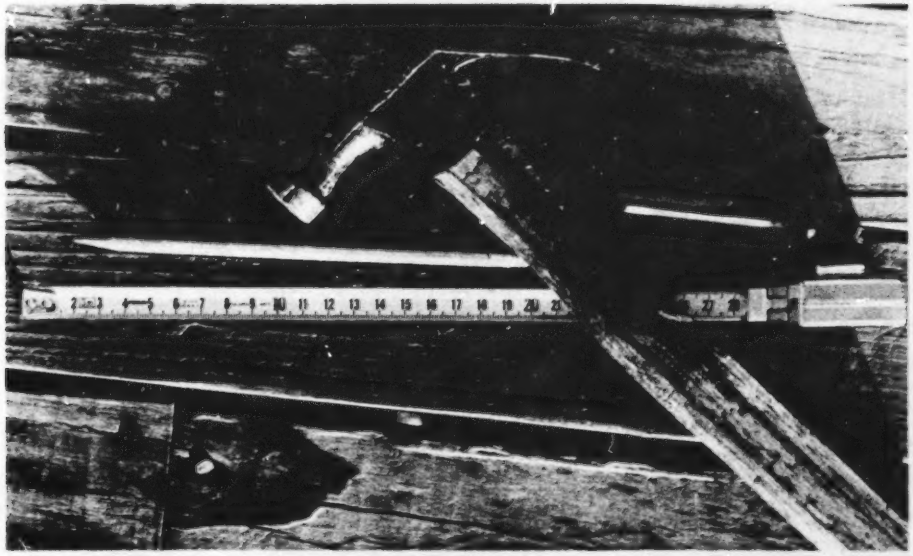


Length

10 kilometers (10 000 meters) is a little more than 6 miles

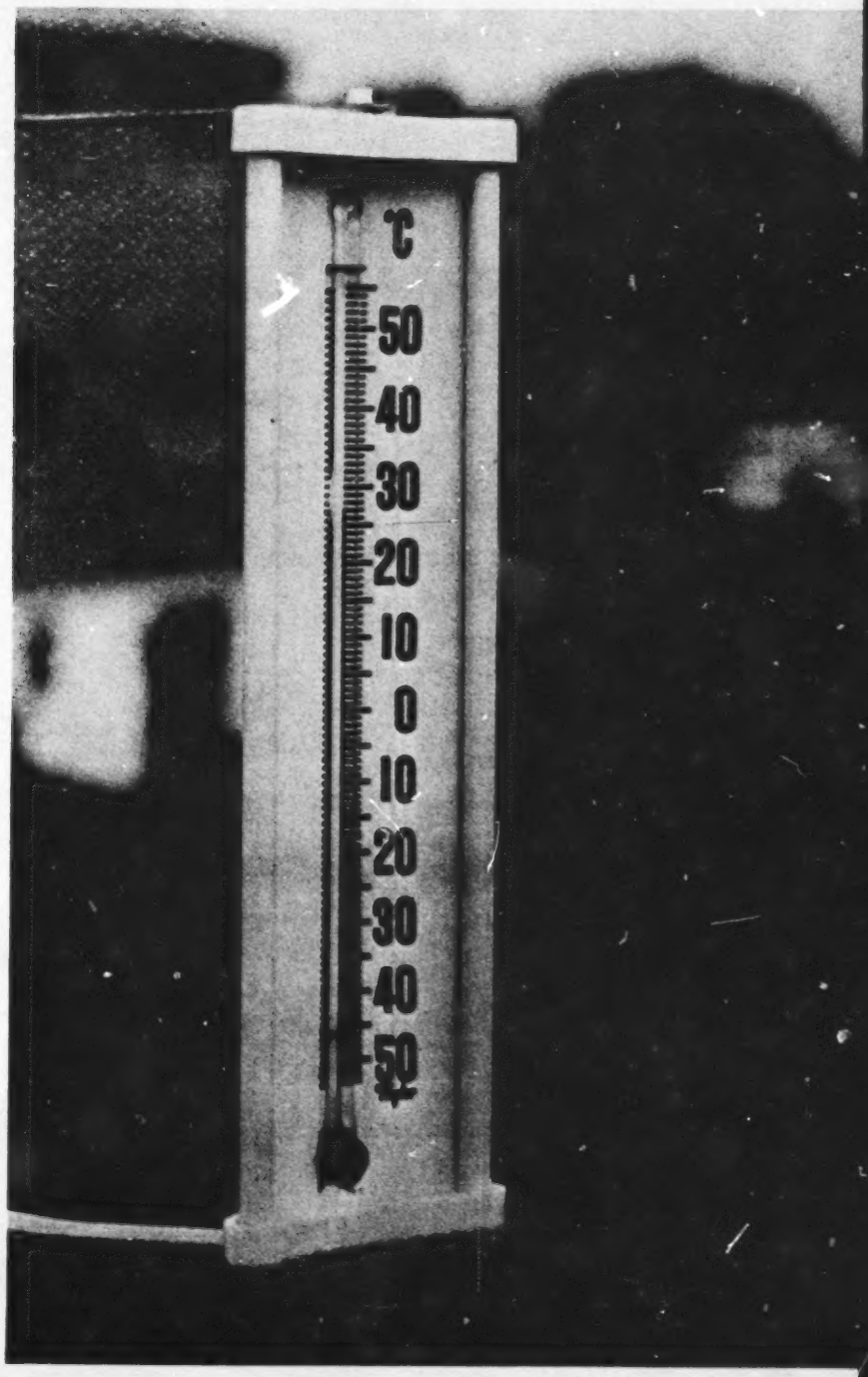
1 kilometer (1 000 meters) is a little more than 1/2 mile

1 meter is a little more than 1 yard



Temperature

100°C	212°F	water boils
37°C	98.6°F	body temperature
0°C	32°F	water freezes



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Volume

5 milliliters is
1 teaspoon

15 milliliters is
1 tablespoon

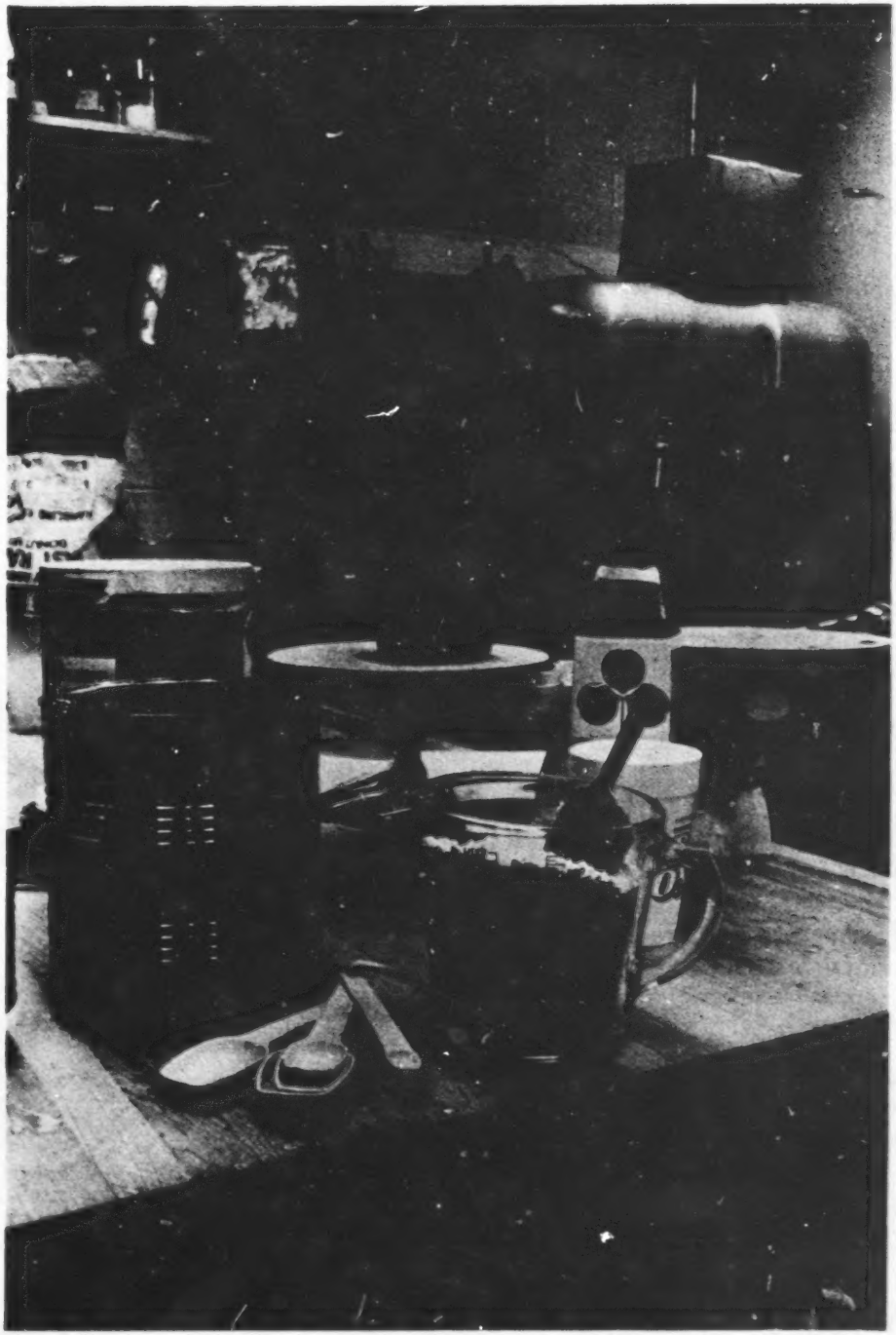
30 milliliters is
1 fluid ounce

250 milliliters is
a little more than 1 cup

500 milliliters is
a little more than 1 pint

1 liter (1 000 milliliters) is
a little more than 1 quart

4 liters (4 000 milliliters) is
a little more than 1 gallon



Calculations

Using Metric and Customary Units of Measurement

The statement and solution of three everyday problems are given in both customary and metric units, providing a side-by-side comparison of the systems.

Problem:

What is the area of the floor of a room with the following dimensions?

Customary Units

length	15 ft 7 in
width	12 ft 6 in

Metric Units

length	4.75 meters
width	3.80 meters

Solution:

The area is determined by multiplying the length of the room by its width. Note that for room dimensions given in mixed customary units it is necessary to first reduce them to a common unit expression.

Customary:

Room Dimensions in Inches

1 foot = 12 inches

length $(15 \times 12) + 7 = 187$ inches
width $(12 \times 12) + 6 = 150$ inches

$187 \times 150 = 28{,}050$ square inches

Room Dimensions in Square Feet

1 square foot = 144 square inches

$28{,}050 \div 144 = 195$ square feet (approx.)

Room Dimensions In Square Yards

1 square yard = 9 square feet

$195 \div 9 = 22$ square yards (approx.)

Metric:

Room Dimensions in Square Meters

length	4.75 meters
width	3.80 meters

$4.75 \times 3.80 = 18.05$ square meters

Problem:

What is the approximate total mass (weight) of the contents of a basket that contains the following items:

Customary Units

Meat	4 lb 9 oz
Potatoes	3 lb 4 oz
Tomatoes	2 lb 15 oz
Cereal	1 lb 7 oz

Metric Units

Meat	2.07 kilograms
Potatoes	1.47 kilograms
Tomatoes	1.33 kilograms
Cereal	.65 kilograms

Solution:

The total mass (weight) of the contents of the basket is determined by adding the mass (weight) of each of the individual items in the basket. Note that for quantities given in mixed customary units it is necessary to first reduce them to a common unit expression.

Customary:

Mass (Weight) in Ounces

1 pound = 16 ounces

Meat	$(4 \times 16) + 9 = 73$
Potatoes	$(3 \times 16) + 4 = 52$
Tomatoes	$(2 \times 16) + 15 = 47$
Cereal	$(1 \times 16) + 7 = 23$
	195

195 ounces = 12 pounds (approx.)

Mass (Weight) in Pounds

16 ounces = 1 pound
195 ÷ 16 = 12 pounds, 3 ounces

Metric:

Mass (Weight) in Kilograms

Meat	2.07
Potatoes	1.47
Tomatoes	1.33
Cereal	.65
	5.52 kilograms

Problem:

What is the volume of the following two comparable but not equal mixtures?

Customary Units

Milk	**1 gal 2 qt 1 pt**
Water	**3 qt 2 pt**
Flavoring	**½ pt**

Metric Units

Milk	**6.5 liters**
Water	**3.5 liters**
Flavoring	**.25 liters**

Solution:

The total volume of all three ingredients is determined by adding the volumes of the individual ingredients. Note that for quantities given in mixed customary units it is necessary to first reduce them to a common unit expression.

Customary:

Volume in Pints

1 gallon = 8 pints
1 quart = 2 pints

Milk
$(1 \times 8) + (2 \times 2) + 1 = 13$
Water
$(3 \times 2) + 1 = 7$
Flavoring = ½
20½

20½ pints = 2½ gallons (approx.)

Volume in Gallons

8 pints = 1 gallon
20½ ÷ 8 = 2½ gallons (approx.)

Metric:

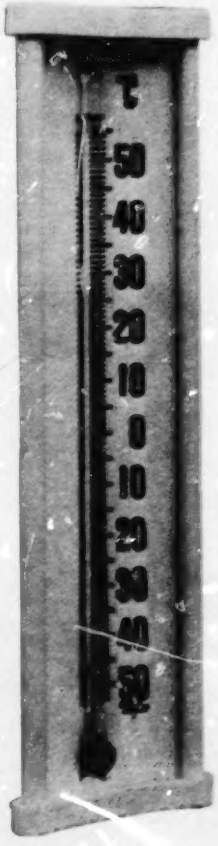
Volume in Liters

Milk	6.50
Water	3.50
Flavoring	.25
	10.25 liters

Everyday Units of Measurement

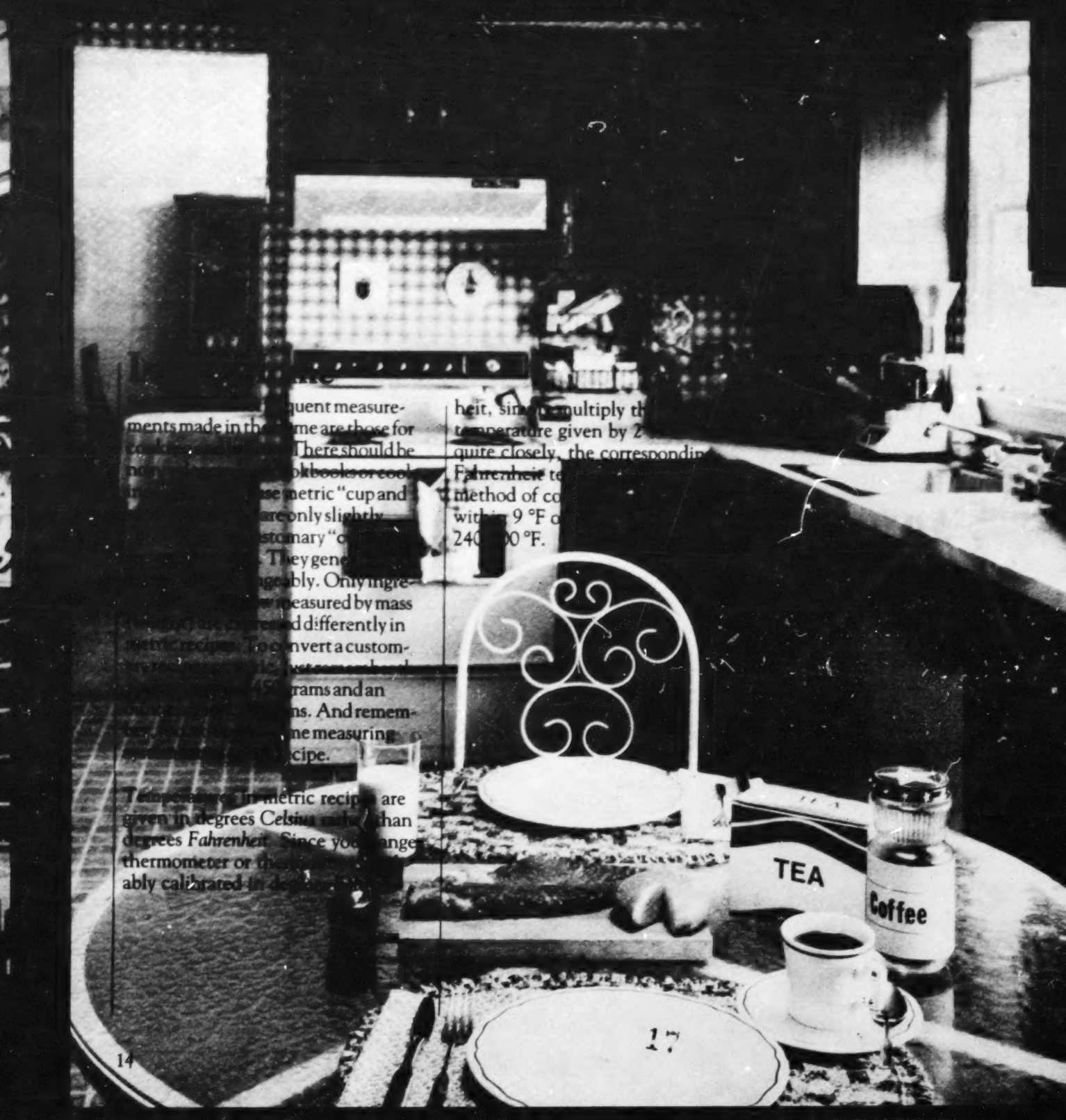
The few metric units of measurement that we will be using in our everyday lives and their approximate sizes are given on this page.

Measurement	Metric Unit	Approximate Size of Unit
Length	millimeter	diameter of a paper clip wire
	centimeter	a little more than the width of a paper clip (about 0.4 inch)
	meter	a little longer than a yard (about 1.1 yards)
	kilometer	somewhat further than ½ mile (about 0.6 mile)
Mass (Weight)	gram	a little more than the mass (weight) of a paper clip
	kilogram	a little more than 2 pounds (about 2.2 pounds)
	metric ton	a little more than a short ton (about 2200 pounds)
Volume	milliliter	five of them make a teaspoon
	liter	a little larger than a quart (about 1.06 quarts)
Area	hectare	about 2.5 acres
Pressure	kilopascal	atmospheric pressure is about 100 kilopascals
Temperature	degree Celsius	see temperature scale at right



Temperature	
°F	°C
212	100
water boils	
98.6	37
body temperature	
32	0
water freezes	

What Will Metric Mean to You?



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Temperatures in metric recipes are given in degrees *Celsius* rather than degrees *Fahrenheit*. Since you change thermometer or the ably calibrated in de

As a Worker

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of tools required as the numbe
izes of fasteners and other com
onents used in the manufacture
of products is reduced.

Sales personnel in hardware, paint,
and fabric stores will also be affected
as conversion occurs in these business
nesses. When a customer comes to
purchase lumber or paint or wallpa-
per, the hardware store employee
may be required to calculate for the
customer the amount needed to cov-
er an area with paint or wallpaper,
or how much lumber will be needed
to build a deck. With the use of
metric, these calculations will be
less complicated. The fabric store